

EXHAUST GAS PURIFICATION APPARATUS

BACHGROUND OF THE INVENTION

[0001]

5 TECHNICAL FIELD OF THE INVENTION

The present invention relates to an exhaust gas purification apparatus.

[0002]

DESCRIPTION OF PRIOR ARTS

Development of a lean NOx catalyst as a catalyst for effectively
10 purifying NOx in lean burn combustion exhaust gas in which oxygen coexists
is progressed, and a catalyst which traps NOx on an adsorbent once, and then
performs reduction purification of the trapped NOx is developed and its
adoption is being expanded.

[0003]

15 Upon mounting this lean NOx catalyst on a diesel vehicle which
performs lean combustion, a working temperature of the catalyst does not
necessarily cope with the temperature of exhaust gas of the diesel engine. That
is, the exhaust gas of the diesel engine is low in temperature by about 100°C
than that of a gasoline engine, so that NOx in the exhaust gas is not
20 necessary effectively purified by the same layout and use manner as the
gasoline engine. Therefore, a method of optimizing the temperature of lean
NOx catalyst by using a heat accumulator, is disclosed in JP 11-125113 A.

[0004]

Further, in the diesel engine, fuel is injected directly into the
25 combustion chamber, so that particle-shaped substances which are called
particulates (PM) are generated. PM comprise soot generated from fuel
having not contacted with air during fuel combustion, SOF (soluble organic

fraction) caused by fuel impinged on a wall of apparatus or the like and lubrication oil, sulfur oxides generated from sulfur in the fuel, etc. PM cause sever injury in respiratory organs and are substances which are unavoidable to be purified in purification of diesel exhaust gas.

5 [0005]

As PM reducing measures, there is a method of trapping PM with a filter which is a diesel particulate filter (DPF), and regenerating the filter by burning PM when pressure loss of the filter increased by accumulation of PM.

- A method of using a heater to burn PM trapped by DPF is disclosed in
10 JP 2001-73748 A or JP 9-137716 A.

[0006]

[Patent Literature 1]

JP 11-125113 A

[Patent Literature 2]

- 15 JP 2001-73748 A

[Patent Literature 3]

JP 9-137716 A

[Patent Literature 4]

JP 10-212933 A

- 20 [Patent Literature 5]

Japanese patent No. 2600492

[0007]

- In the method of JP 11-125113 A, a heat accumulator is provided only on the outer periphery of a NOx catalyst, JP 11-125113 A is silent on heat utilization in the other construction as described later.
25

[0008]

JP 2001-73748 A and JP 9-137716 A each are silent on temperature

raising of the other construction by utilizing combustion heat of PM, as described later.

SUMMARY OF THE INVENTION

[0009]

5 The invention is made in view of the above-mentioned subject of the prior arts, and an object of the invention is to provide an apparatus for and a method of removing un-burnt components such as particulates by DPF, and holding the temperature of exhaust gas purification catalyst such as a lean NOx catalyst in an effective working range and controlling temperature raising 10 of DPF by using its combustion heat, thereby to prevent thermal deterioration of the catalyst.

[0010]

The present invention for solving the above-mentioned subject resides in an exhaust gas purification apparatus for purifying exhaust gas exhausted 15 from a diesel internal combustion engine and containing therein harmful substances including particulates, NOx, HC and CO, at least, which exhaust gas purification apparatus comprises a removal part for trapping and removing at least particulates in the exhaust gas, a purification part for purifying NOx, HC and CO through contact, and a heat transfer part for transferring heat 20 generated in the removal part to the purification part.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is a sectional view of an exhaust gas purification apparatus of an embodiment of the present invention;

Fig. 1B is a sectional view of the exhaust gas purification apparatus, 25 taken along a line 1B-1B;

Fig. 2 is a sectional view of an exhaust gas purification apparatus of another embodiment of the invention, in which an exhaust gas temperature

raising means is provided upstream of a DPF and an exhaust gas purifying catalyst;

Fig. 3A is a sectional view of a part of an exhaust gas purification apparatus of another embodiment of the invention, in which a DPF and 5 exhaust gas purifying catalyst are enclosed by a good heat conductor;

Fig. 3B is a sectional view of a DPF part of the exhaust gas purification apparatus of Fig. 3A, taken along a line 3B-3B;

Fig. 4 is a sectional view of a part of an exhaust gas purification apparatus of another embodiment of the invention, in which a DPF and 10 exhaust gas purifying catalyst are integrated in an integrated one body;

Fig. 5A is a sectional view of an exhaust gas purification apparatus of another embodiment of the invention, in which a DPF and an exhaust gas purifying catalyst are enveloped by a heat accumulating member;

Fig. 5B is a sectional view of a DPF part of the exhaust gas 15 purification apparatus of Fig. 5A, taken along a line 5B-5B;

Fig. 6 is a sectional view of a part of an exhaust gas purification apparatus of another embodiment of the invention, in which a DPF and exhaust gas purifying catalyst, in which the exhaust gas purifying catalyst is arranged of upstream of a DPF;

20 Fig. 7 is a schematic diagram of an exhaust gas purification apparatus of another embodiment of the invention, in which PM combustion heat at a DPF is transferred to an exhaust gas purifying catalyst by exhaust gas;

Fig. 8 is a schematic diagram of an exhaust gas purification apparatus of another embodiment of the invention, in which PM combustion heat at a 25 DPF is transferred to an exhaust gas purifying catalyst by exhaust gas; and

Fig. 9 is a diagrammatic illustration showing relations between exhaust gas temperatures from an engine and harmful substance purifying

ability (NOx purification rate) of a catalyst.

EXPLANATION OF SYMBOLS

- 1...diesel engine, 2, 6, 6a...exhaust flow path, 3...DPF, 4...exhaust gas purifying catalyst, 5...container, 7...exhaust gas temperature raising part,
5 8...good heat conductor, 9...DPF-exhaust gas purifying catalyst integrated structural body, 10...heat accumulating material

[0011]

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

- Fig. 9 is a diagrammatic illustration showing a difference in exhaust temperature property between diesel engine and gasoline engine, and a relation between harmful substance purification ability of a vehicle catalyst and the exhaust temperature properties. The vehicle catalyst, generally, effectively functions at a temperature higher than 250-300°C. In the case of a gasoline engine, the effective temperature range can be selected by devising a catalyst layout or the like.

[0012]

- On the other hand, the diesel engine exhaust temperature is lower by about 100°C than the gasoline engine exhaust temperature, and it is difficult to select an effective temperature range for the catalyst. Therefore, in the present invention, attention is paid on raising the temperature of exhaust gas and/or catalyst by combustion heat of particulates or the like trapped by the DPF, a concrete apparatus and method therefor are proposed.

[0013]

- The present invention is an exhaust gas purification apparatus for purifying exhaust gas containing therein harmful substances such as PM, NOx, HC, CO, etc., which apparatus is characterized by having, at least, a PM removal means for trapping and removing PM from exhaust gas, a purification

means for purifying the NOx, HC, CO, etc. through contact, and a means for transferring heat generated in the PM removal means to the purification means.

[0014]

5 Thereby, it is possible to hold the catalyst temperature in an effective working temperature range by transferring the heat generated by combustion of PM to the purification catalyst for the NOx, HC, CO, etc., and bring out sufficient catalyst ability.

[0015]

10 Further, although PM combustion for regenerating the DPF is accompanied by abnormal temperature rising, it is possible to suppress the abnormal temperature rising of the DPF by rapidly transferring the heat generated in the PM combustion, and it is possible to prevent troubles such as thermal deterioration, breakage, etc. caused thereby.

15 [0016]

For a mechanism, apparatus, or means for transferring heat in the present invention, those based on each principle of conduction, retention and radiation can be applied, particularly, it is preferable to use a means based on fluid transfer which is a kind of conduction and retention.

20 [0017]

As the PM removal means according to the present invention, the following can be applied, for instance, however, various modifications also can be applied within the concept of the present invention, or along the object of the present invention or realization of the object:

25 (1) a monolith honeycomb filter of wall flow type in which an inlet and outlet of extruded honeycomb channel of porous cordierite or SiC sinter are alternately closed;

- (2) a ceramic fiber laminated filter of candle type in which ceramic fiber twists around on the outer periphery of perforated stainless pipe;
 - (3) a cross flow type laminated filter of wall flow type in which extruded plates of porous cordierite are laminated;
- 5 (4) a sintered metal filter that plate-like members made by mixing wire and metal power (Cr, Ni containing powder) and sintering it are laminated;
- (5) a porous metal body filter using a plurality of porous cylinders of metal (Ni, Cr, Al) each made in a three-dimensional mesh-shape;
- 10 (6) a metal wire mesh filter that a stainless wire mesh is formed in a hollow cylinder shape so that exhaust gas flows from the outside to the inside; and
- (7) a filter, having a regenerating function, that a catalyst component such as Pt, Pd, etc is supported on each filter of the above-mentioned
- 15 various kinds of shapes in order to promote combustion of PM.

Although, particularly, there is no limit to the kind of the purification catalyst for NOx, HC, CO, etc in the present invention, a lean burn NOx catalyst which can purify NOx in lean exhaust gas also, a so-called three-way catalyst, a combustion catalyst, a HC adsorption catalyst, an electric catalyst, etc can be applied by being variously modified within the concept of the invention directly or indirectly included.

[0018]

Although, particularly, there is no limit to the lean NOx catalyst, for example, a lean NOx catalyst disclosed in JP 10-212933 A in which NOx is chemically adsorbed under the condition that an amount of oxidizer is more than reducer in the exhaust gas, and the adsorbed NOx is reduced through contact under the condition that an amount of the reducer is the same as or

more than the oxidizer, and a catalyst disclosed in the Japanese patent no 2600492 which has, as a component, a NOx absorbent that NOx is absorbed when exhaust gas is lean and the absorbed NOx is released by lowering the concentration of oxygen in the exhaust gas can be applied for the present
5 invention.

[0019]

Although, particularly, there is no limit to the three-way catalyst, a catalyst which has Pt, Pd, Rh, ceria, etc, as structural components and can purify NOx, HC and CO in the stoichiometric air-fuel ratio exhaust gas
10 simultaneously can be applied for the present invention.

[0020]

Although, particularly, there is no limit to the combustion catalyst, a catalyst which has Pt, Pd, etc, as active components and is able to burn HC, CO, etc in the exhaust gas can be applied for the invention.

15 [0021]

Hereunder, an example in which the DPF is basically used as the PM removal means and a lean NOx catalyst is used as a catalyst will be explained.

[0022]

20 In the present invention, the mechanism, apparatus or means for transferring heat is characterized that it conducts heat transfer through a good heat conductor or a heat conductive member.

[0023]

For example, as the good heat conductor for heat transfer, there is a
25 metal material such as SUS, carbon steel, alloy steel, iron, cast iron, heat resisting copper, copper, copper alloy, aluminum, aluminum alloy, magnesium alloy, nickel alloy, titan alloy, etc, and by transferring PM combustion heat to

the catalyst, it is possible to effectively suppress the temperature rising of DPF and raise the temperature of the catalyst to an optimum temperature range.

[0024]

For example, it is embodied by a heat transfer device or heat transfer part which is constructed by accommodating the DPF and catalyst in a single converter made of the above-mentioned metal material without providing any heat insulator between an inner wall of the converter and the DPF or catalyst.

[0025]

Further, the feature of the present invention is characterized by a heat transfer device or heat transfer part connecting the DPF and the catalyst through a good heat conductor of the above-mentioned metal material, etc.

[0026]

Further, the feature of the present invention can be embodied by the heat transfer device or heat transfer part in which the DPF and the catalyst are made into an integrated structure.

[0027]

In this case, the feature also can be achieved by using the above-mentioned metal material for a substrate of the DPF and the catalyst.

[0028]

Further, as the heat transfer device or heat transfer part, it is also a feature of the present invention to conduct heat transfer by using a heat accumulating material.

[0029]

Basically, regeneration of DPF is continuously conducted and occurs in the case where the DPF itself is made in a catalyst, however, a quantity of heat generation is not always constant because combustion occurs only when a temperature reaches to a predetermined

temperature.

[0030]

Heat generation at the DPF which has not been made catalytic occurs basically only when regeneration is being conducted.

5 [0031]

By transferring the heat generated at the DPF through a heat accumulating material, a quantity of heat transfer can be flattened and it is possible to suppress abnormal temperature rising of the DPF and effectively raise the catalyst to a proper temperature.

10 [0032]

Further, there is an advantage that a heating effect lasts by providing the heat accumulating material.

[0033]

Further, by adopting a heat accumulating material in which phase change occurs and selecting or mixing heat accumulating material of which the phase change is within an effective working temperature range of the catalyst, for example, by selecting a heat accumulating material in which the phase change occurs around a central portion of 300-500°C which is an effective temperature range of a lean NO_x catalyst, the heat generated when
20 PM combustion of the DPF occurs can be used effectively.

[0034]

As the heat accumulating material, for example, inorganic salt, liquid metal such as KNO₃, LiOH, KF-LiF-MgF₂-NaF, etc can be used.

[0035]

25 Further, it is within the present invention to thermally connect the DPF and the catalyst by a heat pipe and to heat-exchange the catalyst and the PM combustion heat by using an exhaust path.

[0036]

Further, in the present invention, a layout and positional relation of the DPF and the catalyst is not limited.

[0037]

5 In the engine exhaust flow path, it is possible to arrange the DPF at the upstream side of the catalyst or to arrange the catalyst at the upstream side of the DPF.

[0038]

10 It is not prevented to provide a rectifier between the DPF and the catalyst or at their front or backside.

[0039]

Further, it is unnecessary for each of the DPF and the catalyst to be single, but it is possible to provide a plurality of DPF and catalysts.

[0040]

15 In the case where the catalyst is arranged upstream of the DPF in the engine exhaust flow, most of the PM combustion heat is exhausted out of the exhaust gas purification apparatus together with the exhaust gas flow, however, according to the method of the present invention, exhausting out of the heat is delayed and the present invention effectively functions.

20 [0041]

The method of the present invention can be further variously modified as follows.

[0042]

25 A temperature raising part which is a means for raising temperature is provided upstream of a PM removal part or PM removal device which is a means for trapping and removing PM such as a DPF, a purifying part or purifying device which is a means for purifying NOx, HC, CO, etc, through

contact, and a heat transfer part or heat transfer device which is a means for the heat generated in the PM removal device to the purifying device of NOx, HC, CO, etc.

[0043]

5 Tightening of the regulation of exhaust gas emission of vehicles makes it necessary to purify harmful substances such as HC, etc. exhausted immediately after engine starting, that is, it is necessary to rapidly raise the catalyst to a working temperature and to reduce greatly harmful substances emitted until the catalyst reaches to the working temperature range without
10 purifying.

[0044]

The above-mentioned construction can attain reduction of a quantity of emission of HC, CO, etc, at the time of engine starting. An electric heater, control of fuel injection timing, etc. can be applied for the temperature raising
15 device.

[0045]

Further, the catalyst according to the present invention can be applied in various shapes. The catalyst can be applied in various shapes such as a honeycomb shape obtained by coating catalyst components on a cordierite
20 honeycomb and a honeycomb structural body formed of metal material such as stainless, a pellet shape, a plate shape, a particle-shape and powder.

[0046]

The present invention relates to an exhaust gas purification apparatus for purifying harmful substances such as particulates (PM), carbon monoxide
25 (CO), hydrocarbon (CO), nitrogen oxides (NOx), etc contained in the gas exhausted from an internal combustion engine of vehicles or the like, and, particularly, to an exhaust gas purification apparatus for internal combustion

engines for raising a purification ratio of the harmful components by keeping the temperature of the exhaust gas purification apparatus to be proper.

[0047]

The present invention will be explained more in detail by embodiments 5 of the present invention. The invention is not limited to the following embodiments and examples, but includes various embodiments within the concept of the invention.

[0048]

Fig. 1A is a sectional view of an internal combustion engine exhaust 10 gas purifying system including an exhaust gas purification apparatus of an embodiment of the present invention.

[0049]

In Fig. 1A, a diesel particulate filter (DPF) 3 for trapping particulates (PM) in an exhaust gas is provided in an exhaust flow path 2 of a diesel 15 engine 1 having a combustion chamber into which fuel is injected by a high pressure pump and an exhaust gas purifying catalyst 4 is provided downstream of the DPF 3.

[0050]

The DPF 3 and the exhaust gas purifying catalyst 4 are 20 accommodated in a single case or container 5 made of SUS which is good heat conductive material. A heat insulator is used for the outer surface of the container 5 if necessary, thereby to prevent heat release from the outer surface.

[0051]

25 A section of the exhaust gas purification apparatus, taken along a line 1B-1B is shown in Fig. 1B.

[0052]

The inner wall surface of the container 5 is contacted with the DPF 3 and the exhaust gas purifying catalyst 4 without intervening any heat insulator therebetween.

[0053]

5 The engine functions as follows:

[0054]

In the diesel engine 1, since fuel is injected directly into the combustion chamber, PM can not help occurring.

[0055]

10 The PM are contained in the exhaust gas, led to the DPF 3 provided in a flow path through the exhaust flow path 2, and trapped by the DPF 3.

[0056]

The DPF 3 increases in pressure loss by trapping the PM, so that it is necessary to remove the PM from the DPF 3.

15 [0057]

Removal of the PM, that is, regeneration of the DPF 3 is performed by combustion of the PM.

[0058]

20 The combustion of PM is performed, for example, by producing a rich exhaust gas through air-fuel ratio control and burning it at the DPF or the like, or by increasing a quantity of un-burnt components and burning them at the DPF or the like.

[0059]

25 The heat generated by regeneration of the DPF, that is, the combustion heat of the PM is transferred to the exhaust gas purification catalyst 4 through the container 5, provided for containing therein the DPF and the catalyst and containing a good heat conductor.

[0060]

The temperature of the exhaust gas purification catalyst is raised by the heat transferred thereto and is held in a working temperature range which is suitable for the catalyst, as shown in Fig. 9.

5 [0061]

Further, since the PM combustion heat is transferred to the exhaust gas purifying catalyst 4, the DPF 3 results in losing of the heat, so that abnormal temperature rising of the DPF 3 is suppressed and its thermal deterioration is prevented.

10 [0062]

As mentioned above, regeneration of the DPF 3, temperature rising of exhaust gas purifying catalyst 4 to a proper working temperature range, and suppression of abnormal temperature rising of the DPF 3 can be attained simultaneously.

15 [0063]

Fig. 2 shows another embodiment of the present invention.

[0064]

A difference between the present embodiment and the embodiment of Figs. 1A and 1B is that an exhaust gas temperature raising part 7 is provided 20 upstream of the DPF 3 and the exhaust gas purifying catalyst 4.

[0065]

The exhaust gas from the diesel engine 1 is led to the DPF 3 downstream of the exhaust gas temperature raising part 7 after being heated by the exhaust gas temperature raising part 7.

25 [0066]

The DPF 3 and the PM trapped by the DPF 3 are raised in temperature by the exhaust gas and ignited to burn.

[0067]

Combustion heat of PM is led to the exhaust gas catalyst 4 through the container 5 constructed so as to contain the good heat conductor, whereby the exhaust gas purifying catalyst 4 is raised in temperature to a suitable 5 working temperature range and abnormal temperature rising of the DPF 3 are suppressed, which is as mentioned above.

[0068]

An electric heater can be used for the exhaust gas temperature raising part 7. An electric catalyst in which a catalyst component is supported on an 10 electric conductor can be used for the electric heater.

[0069]

Fig. 3A shows another embodiment of the present invention.

[0070]

From Fig. 3A onward, only a container accommodating a DPF and 15 catalyst is illustrated.

[0071]

A difference between the present embodiment and the embodiment of Figs. 1A and 1B is that the DPF 3 and the exhaust gas purifying catalyst 4 are enclosed by a single good heat conductor 8.

20 [0072]

A section of the exhaust gas purifying catalyst is shown in Fig. 3B. An inner wall surface of the container 5 is in contact with the DPF 3 and the exhaust gas purifying catalyst 4 through the good heat conductor 8.

[0073]

25 By transferring the combustion heat of PM generated at the DPF 3 to the exhaust gas purifying catalyst 4 through the good heat conductor 8, suppression of temperature rising of the DPF 3 and temperature rising of the

exhaust gas purifying catalyst 4 to a suitable temperature range can be effectively performed.

[0074]

It is possible to make the good heat conductor 8 have a function of preventing displacement of the position of the exhaust gas purifying catalyst 4, a function of preventing gas leakage from gaps between the container 5 and the DPF 3 and/or the exhaust gas purifying catalyst 4, and a function of absorbing vibrations, other than the inherent heat conducting function for the present invention.

10 [0075]

Fig. 4 shows a further another embodiment of an exhaust gas purification apparatus of the present invention.

[0076]

A difference between the present embodiment and the embodiment of Figs. 1A and 1B is that the DPF 3 and the exhaust gas purifying catalyst 4 are integrated into an integrated structure 9, and a substrate of the catalyst is made of metal material.

[0077]

As the integrated structure 9, a three-dimensional mesh-shaped porous body of which a front portion is made as a filter and a back portion has a catalyst component supported thereon, and a sintered porous metal body constructed the same as the above can be applied.

[0078]

Further, an integrated structure 9, which is formed by welding to connect a filter composed of a three-dimensional mesh-shaped porous metal body, a sintered porous metal body or wire meshes to a so-called metal honeycomb structure formed by adhering and working stainless plates into a

honeycomb structure, also can be applied.

[0079]

Fig. 5A shows a further another embodiment of the present invention.

[0080]

5 A difference between the present embodiment and the embodiment of Figs.1A and 1B is that the DPF 3 and the exhaust gas purifying catalyst 4 in the exhaust pipe 2 are surrounded by a heat accumulating member 10.

[0081]

A section of the exhaust gas purification apparatus is shown in Fig. 5B.

10 The inner wall surface of the container 5 is thermally connected with the DPF 3 and the exhaust gas purifying catalyst 4 through the heat accumulating material 10.

[0082]

15 By transferring the heat from the DPF 3 to the exhaust gas purifying catalyst 4 through the heat accumulating member 10, a heat transfer quantity can be flattened, and suppression of temperature rising of the DPF 3 and temperature rising of the exhaust gas purifying catalyst 4 to a suitable temperature can be more effectively performed, that is, can be performed so as to last longer in the more proper temperature range.

20 [0083]

Fig. 6 is a modification of the embodiment of Figs. 1A and 1B, in which the exhaust gas purifying catalyst 4 is arranged upstream of the DPF 3 in the exhaust flow inside the container 5 containing a single good heat conductor.

[0084]

25 In the construction, in the case where there is sufficient heat transfer between the container 5 and the exhaust gas purifying catalyst 4 and the DPF 3, more of the PM combustion heat in the DPF 3 is taken out by the exhaust

gas, and the heat does not serve temperature raising of the exhaust gas purifying catalyst.

[0085]

According to the present embodiment of the invention, the PM combustion heat generated at the DPF 3 flows in a reverse direction to the exhaust gas flow, and is used for temperature raising of the exhaust gas purifying catalyst 4.

[0086]

A relative positional relation between the DPF 3 and the exhaust gas purifying catalyst 4, that is, arrangement of the exhaust gas purifying catalyst 4 at the upstream side of the DPF 3 can be applied for all the embodiments shown in Fig.1A to Fig. 5B. In any case, the PM combustion heat at the DPF 3 at the downstream side is transferred to the exhaust gas purifying catalyst 4 at the upstream side through the container 5, the good heat conductor 8 or the heat accumulating member 10, and can attain the same function and effect as in the embodiment of Fig. 6.

[0087]

Fig. 7 shows further another embodiment of the present invention.

[0088]

20 A difference between the present embodiment and the embodiment of Figs. 1A and 1B is that the temperature of the exhaust gas purifying catalyst 4 is raised by using the exhaust gas of high temperature produced when PM is burnt at the DPF 3.

[0089]

25 The exhaust gas purifying catalyst 4 is arranged upstream of the DPF 3, and the heat generated when PM is burnt at the DPF 3 is carried on exhaust gas and transferred to the exhaust gas purifying catalyst 4 positioned

at the upstream side by using a pump 11 or the like arranged in an exhaust flow path 6a fluidly connected to the exhaust flow paths 2 and 6.

[0090]

The construction is effective when the DPF 3 is arranged downstream
5 of the exhaust gas purifying catalyst 4.

[0091]

Fig. 8 shows further another embodiment of the present invention.

[0092]

A difference between the present embodiment and the embodiment of
10 Fig. 7 is in a shape of the exhaust flow path and a heat transferring
construction, and an exhaust gas transfer part of the pump or the like is
unnecessary, as compared with Fig. 7.

[0093]

A part of the exhaust flow path 6 arranged downstream of the
15 container 5 is turned to the container 5 to be in contact with a part of the outer
surface of the container 5 and returns to the downward as shown in Fig. 8.

PM combustion heat of the DPF 3 is transferred to a position near to
the exhaust gas purifying catalyst 4 which is a heat receiving body by exhaust
gas, and then the heat is transferred to the exhaust gas purifying catalyst
20 through the good heat conductor.

[0094]

In Fig. 8, it is effective as a modification to provide a heat
accumulating member between the container 5 and the exhaust flow path.

[0095]

25 As mentioned above, according to the present invention, it is possible
to effectively purify particulates, NOx, HC, CO, exhausted from an engine.